Recent advances in mapping tree roots using ground penetrating radar

Luca Bianchini Ciampoli[1], Amir. M. Alani[2], Fabio Tosti[2], Andrea Benedetto[1]

(1) Department of Engineering, Roma Tre University, Rome, Italy (luca.bianchiniciampoli@uniroma3.it; andrea.benedetto@uniroma3.it)

(2) School of Computing and Engineering, University of West London (UWL), London, United Kingdom (Amir.Alani@uwl.ac.uk; Fabio.Tosti@uwl.ac.uk)

Environmental issues and preservation of natural heritage, especially ancient trees and rare plants, are becoming priority objectives to achieve. Unknown pathogens carried along by the wind can lead to epidemic phenomena and often to a quick death of entire forests. To this effect, active and passive methods can be used to reduce the risk of premature death of trees. Passive methods rely on the application of policies for the control and the management of the forestall heritage. These are based on the monitoring of living trees and are aimed at identifying the early-stage symptoms of the disease. Within this context, use of destructive testing methods is increasingly discouraged, and non-destructive testing (NDT) methods are emerging as the only viable solution for a non-intrusive assessment of the disease. The ground penetrating radar (GPR) non-destructive testing method has proved to be one of the most powerful NDT methods, due to a high versatility, rapidity in data collection and the provision of reliable results at relatively limited costs. Applications of GPR in forestry science are related – but not limited to - the effective tree trunk assessment and appraisals, tree roots mapping, soil interaction with tree and plants.

This study reports a demonstration of the GPR effectiveness in tracking tree roots. The main objective of the research was to provide an effective and high-resolution mapping of the tree roots. To this purpose, the soils around a fir tree and an oak tree were investigated using a ground-coupled multi-frequency GPR system equipped with 600 MHz and 1600 MHz central frequency antennas. A dedicated data processing algorithm was firstly developed to filter out the data from noise-related information and to highlight deep reflections from attenuated targets. At a later stage, a multi-step algorithm pinpointing the identified targets (i.e., the vertex of the reflection hyperbolas) in a three-dimensional environment was created.

Results have proven the viability of GPR in mapping tree roots for different species of trees. The proposed algorithm has allowed to successfully identify both shallow (i.e., within the first 25 cm from the soil surface) and deep (i.e., underneath 25 cm of depth) tree root systems.

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